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ABSTRACT

This publication is the third of three publications to assist school business officials with the challenges of improving school facilities. This report explores issues relating to technology implementation in school buildings, including cost and finance issues, space requirements, classroom configuration, equity in technology availability, staffing, infrastructure development, security, and environmental issues. The report also explains the development of building technology plans for both individual schools and school districts. Appendices provide Internet, book, and professional organizational resources for help and a basic technology checklist. (Contains 12 references.) (GR)

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ED 474 203

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TECHNOLOGY SOLUTIONS FOR SCHOOLS

A report prepared by ASBO International's® Facilities Project Team

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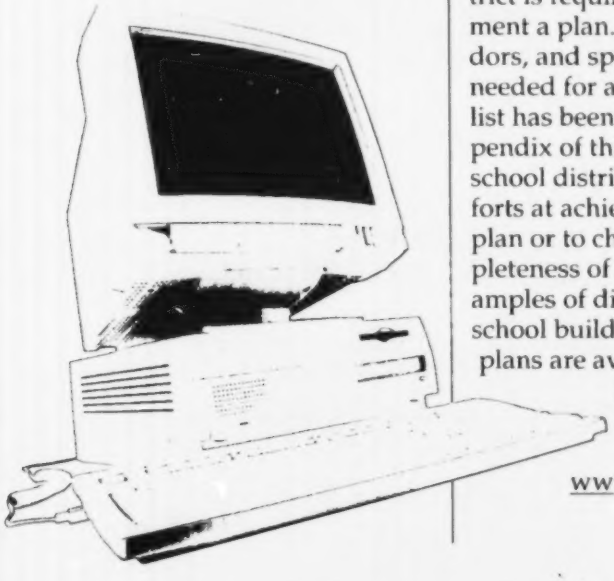
TECHNOLOGY SOLUTIONS FOR SCHOOLS

School officials are faced with many questions that need to be addressed when implementing a school district-wide or school building technology plan. The technology industry is changing rapidly, making it even more important that the practitioner has access to reliable information. This constant push and pull in the field of electronic technology makes it difficult for school officials to implement an up-to-date technology plan given the constant budget constraints of every school district.

Heavy demands are placed upon educators operating school districts making it difficult to become acquainted with or stay abreast of what is happening in the field of technology. In an effort to assist the practitioner in understanding this important area, the Association of School Business Officials International® commissioned this publication, which is a quick read, how to manual on technology and school facilities. The document purposefully does not cover curricular issues related to the use of technology because of the unique demands for knowledge relating to this specific topic. This publication is written expressly for school business officials to present many points of discussion relating to technology and school buildings. Because of the scope of the publication, many topics are presented in introductory terms. Resources listed in the appendix provide a means for obtaining more in-depth discussion of the subject.



The Technology Plan

It is important that school districts and each school building have a thorough and current technology plan. Developing a plan or revising an existing plan should be a priority for school districts. Considerable work on the part of many different employees within the school district is required to fully implement a plan. Consultants, vendors, and specialists may be needed for assistance. A checklist has been included in the appendix of this document to help school districts evaluate their efforts at achieving a thorough plan or to check on the completeness of an existing plan. Examples of district-wide and school building technology plans are available through the National Center for Technology Planning at http://www.nctp.com/.

School District Plan

Every school district needs to have a system-wide technology plan to guide the development of the use of all technological applications. The district plan should:

- include the district's technology implementation goals
- describe the place and purpose of technology in the educational program for all students
- describe the types of educational programs that will need technology support, the grade levels where appropriate, and the extent of sophistication of technology
- give guidance to all personnel regarding the appropriate types of hardware and software to be acquired
- describe the extent of school district support for technology
- include a policy regarding the purchase of computer hardware, software, and other technology applications by organizations on the local school building level
- contain a statement regarding the equal availability of all technology applications to students no matter where that student attends school
- address the use of technology to enhance the administrative function of the school district by improving efficiency and accountability of the organization
- give indication of how technology can be used to provide an infrastructure base to support learning activities
- identify the types of data to be gathered, analyzed, and disseminated, as well as the purpose for which it will be used (Picciano, 1998)

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School districts must report considerable data to various local, state/provincial, and federal government offices to comply with regulations and legal dictates. In addition, both the individual schools and the school district report progress and activities to parents, community members, and organizations. School districts gather a great deal of information about employees, students, buildings, funding, and every other aspect of the organization. The accounting of this body of data is a large task that could not be done without the aid of technology. The sophisticated technology now available to school districts enable them to make better administrative and instructional decisions and to provide more informative reporting. All of the reporting responsibilities of the school district should be identified and discussed in the technology plan.

School Building Technology Plan

Each school building within the school district needs to have a technology plan in place to describe what staff and administration would like to see implemented on the building level. Although each individual building has specific needs for technology applications that will accommodate the student body enrolled and the educational program offered, each plan must fit into the overall school district plan. This is especially true for the hardware that will be purchased and used at the local school building. Using the district plan as a starting point will ensure that each student has an equitable opportunity to access technology.

The contents of the building technology plan should be a reflection of those contained in the school district plan. Headings in the plan might include:

- the mission of the technology plan
- the student learning goals to be accomplished
- implementation strategy that teachers will use
- types of software programs available
- types of hardware that will be needed
- grade level appropriateness of software
- method of evaluating the effectiveness of software and hardware
- measurement of student learning

Making Good Technology Decisions

There are several functions, practices, and data sources that are critical in making good technology decisions. The first of these is a thorough technology requirements document that addresses the functional, management information, performance, human factors, and integration required to interface with other systems in the school district (Coulter, 2001, personal communication). Second, the school district technology team and facilities team should fully participate in the decision-making process. Technology decisions require the collaboration and input from a number of local and national sources. Appropriate computer infrastructure is needed to facilitate the information gathering and decision-making process. Finally, the key to making good technology decisions is making sure potential suppliers are asked appropriate questions that will give you their perspective on the capabilities of a technology and its long term viability.

Collaborative Planning and Funding

The one element that is so characteristic of planning in public schools is the collaborative nature of the process (Sanoff, 2001). Schools and school districts are noted for involving large numbers of individuals within and outside of the formal organization. Parents and community leaders are usually involved in every stage of planning that occurs in schools, regardless of what is being planned. Their involvement is especially important when a school district or building is developing a technology plan. Collaborative planning of school facilities is essential because the recipients of the product of the planning process also are the source of funding and as a result need to have an opportunity to express their opinions during the planning process.

The planning process for facilities, which includes the identification of needs as well as planning for the building itself, is a very important venue for community involvement.

In the United States, the federal government and many states have enjoyed budgetary surpluses in the past few years, yet extra tax funds have not trickled down to the local government level. Few, if any, local government units or school districts had surplus funds from the approved budgets during the past five years. With the prospects of fewer tax funds in the coming years, school districts must continue to provide more services with fewer funds. Some school districts have successfully augmented the local tax-capital budget through alternative funding sources.

Linking High-Tech Facilities to Public Relations Efforts

School districts may use the technology they have available to them for public relations efforts including:

- Creating a Web site to provide information about the school district and each school building for the community
- Establishing an e-mail list serve to communicate with parents regarding meetings and homework
- Opening computer labs after school for students who do not have a computer at home
- Permitting community members to use school computers when not used by students
- Providing after school computer instruction to community members
- Using the high school television studio to broadcast programs over the local TV station
- Broadcasting the school board meeting over local TV stations using school equipment

Cost and Finance Issues

Wiring and remodeling buildings and purchasing telecommunications equipment represent substantial and genuine capital expenditures. Schools should not be expected to pay for all expenditures out of operating budgets at one time. Schools and school districts wishing to advance quickly have to overcome the problem of meeting a substantial front-end capital cost. The traditional instrument of choice, the 30-year bond issue, does not match the three-year life expectancy of computer technology (Lumley & Bailey, 1993). However, some school districts have adapted by offering shorter-term technology bonds.

Leasing has become a very popular alternative to purchasing technology hardware in school districts. Some school districts are finding it more cost effective to enter into a taxable leasing arrangement than to purchase equipment even though purchases are made with tax-exempt funds. Other benefits of leasing include keeping current with technology, implementing system-wide software, and keeping the faculty abreast through professional development. School districts should explore the possibilities of leasing before entering into long-term bonding programs for technology. The appendix contains references for more information about leasing.

The U. S. Department of Education awards grants and contracts to schools and school districts to implement new technologies. Information about current funding opportunities and documents that will help you understand the grants and contracts processes and rules is available at http://www.ed.gov/funding.html.

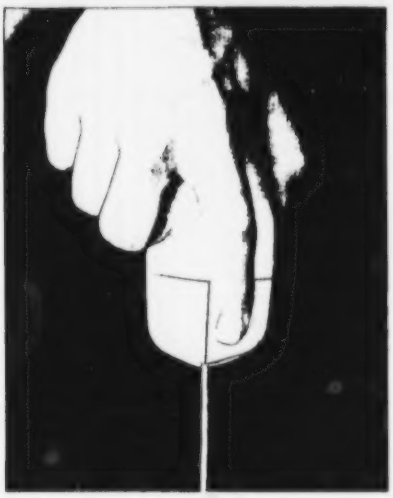
Other U.S. federal funding possibilities include Title 1 and Title 2 grants. Schools may use those funds on a school-wide basis rather than allocate them only for the poorest students. Schools also may be allowed to combine monies received from multiple federal programs. The Individuals with Disabilities Education Act allows federal money to be used to provide assistive technology for students with disabilities.

The national governments of other countries, including Canada, provide funding possibilities that should be investigated by school authorities.

On the state/provincial level, there has been a growing trend to allocate the funds needed to wire schools for telecommunications under school reform legislation or other initiatives. Florida has spent millions of dollars to help retrofit schools so they can use a statewide information resources network.

Locally, it is often possible to find money within the existing capital and operating budgets. Technology can reduce funding for traditional supplies. The attendant on-line resources will allow for reallocation of portions of text and library book budgets. A school district also can enlist the aid of nearby businesses by organizing a forum of local business leaders who know the skills students need to join the workforce. A business can be asked to donate money for a pilot program or to form major partnerships with school districts. A school district may establish joint purchasing plans with other school districts and with county and state/provincial governments and other entities. The creation of a non-profit education foundation can encourage businesses, organizations, and individuals to donate money, equipment, and expertise to school districts. Many major corporations and foundations provide funding, though these are usually very competitive processes. Another strategy is to seek the support of telephone companies.

Several corporate foundations support education programs that focus on the use of technology to enhance teaching and learning, concentrating on the role of technology in education and its capacity to connect students, teachers, classrooms, institutions, and communities.



School districts may form regional consortiums to buy instructional software, create communications networks, and develop teaching and training methods. In some cases, lease arrangements allow for installation, maintenance and repair, and training sessions.

Total Cost of Ownership

A business concept called Total Cost of Ownership (TCO) can help school leaders understand what is really involved in implementing technology. TCO represents all of the costs involved with installing, operating, and maintaining a network of computers over a period of time (Beaudin and Sells, 1999).

The Consortium for School Networking (CoSN) has launched an initiative called *Taking TCO to the Classroom* to introduce the concept of TCO to school leaders. CoSN is a nonprofit coalition of school districts, state and regional education groups and networks, corporations, and education organizations that promotes the use of telecommunications in K-12 classrooms to improve learning. Intel and IBM support the TCO project.

Space Requirements

Instructional Space

Every classroom, laboratory, and instructional area need some space to accommodate computers. In addition to the physical space needed for each computer and student movement, the instructor needs to have some space to provide direct instructions and demonstrations to students. A computer usually needs approximately 30 square feet of space, which includes normal circulation around it. Newer computer furniture might require less space, but approximately 25-30 square feet must be dedicated to each computer in a classroom. Teachers should have approximately 50 square feet of instructional space, including a wall writing space with a chalk-less writing surface of at least 4-6 square feet.

Computer Lab

Many school districts have at least one computer laboratory in every school building. The computer lab is used primarily for instruction in computer literacy and keyboarding but also can be used for other instructional activities. A computer lab does not negate the need for computers in every classroom and instructional space.

A computer lab is generally designed to accommodate 25-30 students in one area. The physical layout should meet the requirements of the educational program and the needs of the type of student who will be using the facility. There are several computer layout patterns that can be used: row, cluster, and perimeter design. The row configuration is a common design for computer labs. Workstations are arranged in rows similar to a regular classroom. The benefit of this design is the efficient use of space and the mobility of students and teacher. The teacher at the front of the room can provide instruction with a minimum of distraction. The cluster design groups four computer workstations to make a cluster. This design provides for a great deal of open space with considerable mobility of students and teacher. A number of students can work as a group and create collaborative learning environments with this arrangement of furniture. The perimeter design places most of the computer workstations along the walls of the room allowing the center of the room to be used for group activities. This design is the least efficient utilization of space and does not lend itself to large group instruction by the teacher.

Regardless of the design of the computer lab, considerable thought must be given to the type of furniture used. Large open worktables permit the greatest flexibility and provide workspace at the computer. Furniture must be sized appropriately for the various groups that will use the facility. Elementary schools present the biggest challenge.

Proper lighting must be designed into the computer lab to prevent glare on the work surface of the desk and monitor. Glare can be very distracting to students while working at a computer. Natural lighting can be a source of glare and should be controlled by the use of adjustable blinds.

The teacher workstation needs special attention. Large monitors (36 inches) and video projection systems have become the standard for computer-

based instruction. Light switches or controls should be centralized so the teacher can control the room lighting for certain presentations. The teacher also needs a moveable high stand for the keyboard so that instruction, keyboard operations, and commands may be given while standing. Overhead projectors and a chalk-less writing surface should be provided for instructional purposes.

Some educators question the need for a computer lab in light of recent advances in wireless applications and laptop availability. They argue that it is no more expensive to provide wireless laptop computers to every student than to equip a computer lab. In addition, the amount of space required for a computer lab can be used for other educational purposes. There have been a few schools in the nation that have supplied every student with a laptop computer with great success (NEA, 2001). Educators need to keep abreast of the most current developments in wireless applications to enable them to make informed decisions. Further, the level of the student, elementary, middle, or high school, will greatly influence decisions on the need and use of computer labs.

Media Center

The library/media center is no longer a depository for books and audiovisual equipment. With the advantage of the Internet, students can go beyond the walls of the library to any source of information in the world. Because of this, the space now devoted to the information function has changed. The public school has not abandoned the print book function of the library, but has increased attention to the needs of students in obtaining information through electronic transmission. The heart of this effort is the media center. This space could house the television studio, multimedia production lab, student/staff production area, computer training room, head-end distribution control room, information commons area, editing facilities, and offices. In addition, a distance learning lab could be attached to the media center. The distance learning lab should be equipped to serve more than one function. Students would be able to receive lessons from outside of the building, but the lab also could permit instructional activities with a teacher providing demonstrations and the students working from a computer. Schools must decide whether learning from home and having remote access to school electronic files and programs is a frill or an essential component of the school's education strategy. Increasingly, access from home is becoming essential.

Two interesting space ideas can be incorporated into the media center. These spaces are called the information commons and the electronic café (National School Boards Association, 1998). The information commons incorporates the old functions of the circulation desk and card catalogue into an electronic version that permits the student to access a variety of information sources and complete several information tasks. The electronic café allows for further student access of centralized information through a variety of individual stations. These stations might include stand-up counters for quick information retrieval, space for small group activities, individual research stations, and space for larger groups working on a media production activity. The key to this space is flexibility in design and movement of students.

Lighting for the library and media center must be adapted for both general work and for specific tasks. Glare is a large problem in the media center particularly when it falls on a computer screen. Steps should be taken to eliminate glare within the computer areas. The lighting should be flexible enough to accommodate the various tasks in the area. This can be attained by a combination of lighting sources, such as wall-washer light fixtures, cove lighting, recessed downlighting, and general fluorescent lighting (NSBA, 1998). A good illumination engineer, who can specify the correct lighting combination for the needs in the media center, should be employed to insure proper lighting.

Office

Two types of offices are needed in the media center. The main office is a workstation for the person who is in charge of the center's operations. This person may be the librarian or the media specialist, depending upon the size of the school district. This office should be near the main entrance to the center and allow for visual supervision of the traffic, as well as the rest of the center operations. The furniture and equipment needed by the occupant of this space should include a desk, chairs, plus computer and other electronic equipment needed for communication.

The other offices are for students who might be working on an individual research project. There might be three or four such offices, depending upon

the size of the center. The offices would be available on a student demand basis and would not necessarily be assigned to specific individuals. A work surface, chair, and computer plus other electronic equipment should be available in this space.

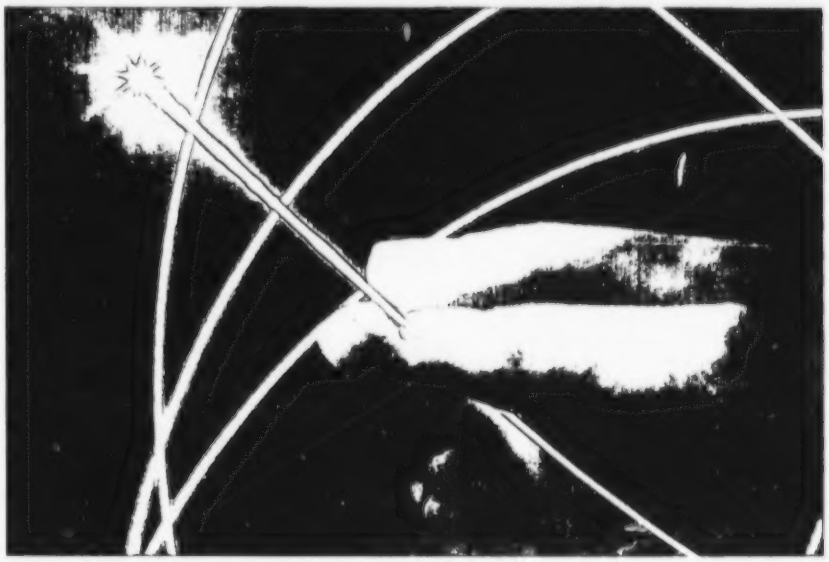
Commons Area

The commons area in most schools is used for a variety of activities including lunch, assemblies, and staging of students waiting for transportation. In addition to these activities, the commons area also can be used for instructional and learning activities throughout the day. To use the commons area to its full capacity, it must have sufficient electrical outlets for computer activation and data ports where students can access the Internet. The outlets and ports should be located on wall surfaces and grouped for efficiency. Students should be able to plug their laptop computers into an outlet for homework assignments or class activities and if needed into an external data port. The cost of these outlets and data ports is extremely small in new buildings, but installation in existing buildings may be more costly. However, the student learning benefits of having the outlets and data ports available in the common area more than outweigh the expense of installation.

Configuring Individual Classrooms

Basic Considerations

The space requirements for general-purpose classrooms are usually determined through a formula using the number of students assigned to the space and a set amount of space. Typically, general-purpose classrooms are planned and designed based upon a standard of 25 students to a space with 30-35 square feet of space allocated for every student. This formula results in a classroom of 750-875 square feet of space. These standards are usually determined and set by the educational authority for each state or province. There may be some variation, but for the most part this formula prevails in the allocation of space for classrooms.



In most states/provinces, the local school district is required to build classrooms that meet the set standard. In addition, states/provinces that provide some financial assistance to the local school district for building schools require adherence to the standard to receive payment. In many cases, the state/province will reimburse the local school district only for the required space in the classroom. If the classroom is built larger than the required standard, the local district must pay for excess amounts of space.

With the advent of computers as a staple of the educational program, school administrators placed computers in the classroom to augment the instructional program. In many school districts, there was little thought about the amount of floor space computers would require. As a result, the classrooms with 25 students seemed very crowded. In addition, computers increase demand on the air conditioning/ventilation requirements for each space. The addition of 4-5 computers in a classroom might require as much as 15% more air handling.

Space Requirements

Research and practice has amply demonstrated that a computer displaces the same amount of floor space as a student. Every computer in the classroom is equal to the amount of space needed for a student, which in most instances is 30-35 square feet of space. If the approved number of students in a classroom is 25 and 8 computers are to be placed in the classroom, the classroom space needs to be enlarged to accommodate the

equivalent of 8 additional students or the classroom capacity must be reduced by 8 students to accommodate the computers. This is a very simple concept to understand, but difficult to implement.

Some authorities in the field indicate the standard general-purpose classroom should contain an average of 1000 to 1200 square feet of space (Lumley & Bailey, 1993). This size is very desirable, but few state/provincial departments of education require or encourage that much space for general-purpose classrooms. Additionally, trying to create such large classrooms in an existing building might be extremely difficult because of structural limitations and restrictions in the amount of space available.

Critical Factors

Every classroom, laboratory, and instructional space in the school needs to have the capability of receiving and sending voice, video, and data signals throughout the building and outside of the building to other locations. This should be the standard specification for all spaces in a new building or a renovated existing building.

Students in the classroom should have the capability to access the Internet, receive and send voice and electronic mail, receive data electronically, analyze it and send it to various locations, even outside the building. In addition, students should be able to receive and participate in closed-circuit television to augment their learning activities.

Networking Computers

Internal and external networking of computers should be addressed early in the school building planning process. Both internal building networking and external networking must be addressed. Most school districts provide for some type of networking in the individual school buildings. Every computer in the building does not have to be networked, but sufficient numbers located in strategic locations need to be networked to facilitate instructional/learning strategies. Several students can be working together on a project through the use of networked computers. The installation of a local area network (LAN) where computers are networked internally and with other buildings in the school district is very appropriate and economical. Software can be used by a number of students at the same time through the LAN. The degree of networking, how the LAN will be configured, and program availability is usually a school district-wide decision based upon educational program needs and available resources.

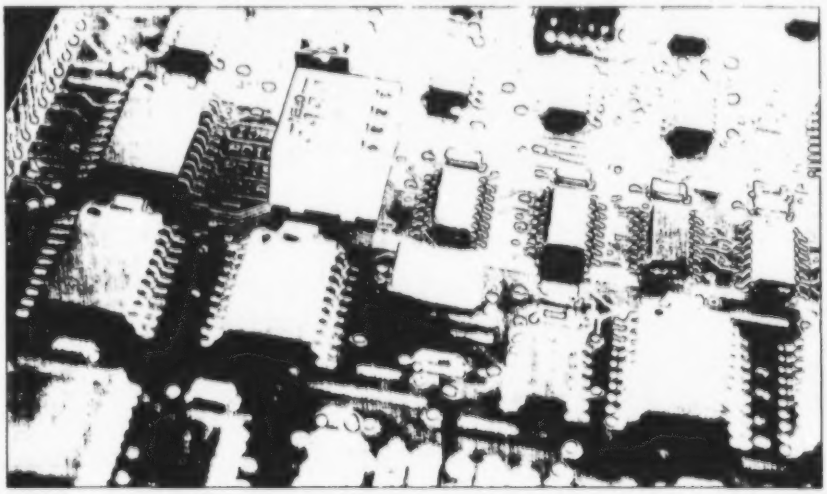
Wide area networks (WAN) permit access to a variety of instructional applications in addition to offering the services of the LAN through external networking. The WAN provides access to a world of resources using the services of the Internet. The best services available through a WAN are provided by national networks that allow access to various databases. Access to encyclopedias, research databases, information exchanged and technical documentation can be provided. This is in addition to electronic mail services.

Grade Level

Typically, elementary school classrooms are somewhat larger in size than secondary school classrooms because of the amount of student activity. Regardless of the size of the classroom space, if computers and other technology equipment are introduced into an existing classroom, the student capacity needs to be reduced to accommodate the student displacement.

Classroom Furniture

Generally, tables and chairs are more useful and flexible than standard desks, regardless of the grade level. The flat surface of a table permits the students to use laptop computers at their seats.



Other Classroom Technology

The introduction of computers into the classroom has been a great help to both instruction and learning. Students now have access to computers for many learning purposes. The computer, however, is not the only technology that students and teachers can use within the confines of the classroom. The ability of students to seek information outside of the classroom via the Internet opens a whole new world of learning. Students in the most remote section of the country are able to access the Library of Congress or other sources of information just as easily as students who live next to these sources. In addition, students can communicate with others in every part of the world through the use of e-mail, and video imaging.

Voicemail for teachers offers a means for better communication to parents and students. This communication also enhances the public relations effort of the individual school building. For instructional purposes, the use of television with many different types of sources of information is a great help to the teacher. Equipping the television with call-up potential for videos allows the teacher to be assured of a quality production and availability when needed.

Equity Issues

Equal Availability

Equal availability refers to the equal treatment of students regarding the availability of technology. Every student in the school district must have the same access to all of the technology, regardless of location. This includes not only the number and type of equipment, but also the type of instructional program and activity utilized.

Equal availability can be successfully promoted through school board policy on the district level, but also should be guaranteed through the administrative practice of providing equal opportunity and services in every building. The school district, through the school board policy regarding technology implementation, can insure that regardless of the building location of a student, equal treatment will prevail.

This policy is especially useful when a new school building is opened with a sophisticated technology program. The same hardware, software, programs, and equipment need to be available to students located in older school buildings. Equal availability in this case may mean implementation of a special renewal program upgrading all existing school buildings when a new building is opened. Special funding for such a program must be incorporated into the capital budget of the school district. The timing of implementation of this program is crucial to prevent inequity over a long period of time.

Equity also has several other applications in addition to equal accessibility. Student gender, minority status, and socioeconomic issues come into play when dealing with technology. Research regarding use of computers by gender is inconclusive, however, if technology is to be an important part of the curricula, schools should attempt to overcome any possible gender issues. The minority and socioeconomic issues deal mostly with the lack of availability of computers and other technology in the home of some disadvantaged students. Schools should provide after school programs when computers and other technology are not usually available in the home.

Uniformity of Technology Application

The application of technology in a school district should be uniform for the most efficient use of all equipment and programs. The school district should develop a set of uniform technical specifications regarding the type of electronic equipment and furniture that will be used in every school in the district. These specifications should be included in school district policy and assist the staff in every school building by indicating the systems, equipment, programs, and applications that can be purchased.

Special Populations

It is important to address the needs of students with a disability or impairment when implementing new technology. Assistive technology has been employed to help these students learn and communicate with others. Assistive technology is the use of technology to assist an individual with physical and/or cognitive, learning, or speech disabilities to perform functions that may otherwise be difficult or impossible. Assistive technology ranges from inexpensive low-tech solutions to higher cost high-tech solutions. Assistive technology may involve adapting a computer with a specialized method for the user to operate the computer. It may be the use of special software to aid an individual to read, write, or perform other academic tasks on the computer. For these students, computer technology is the primary

means of communicating with the outside world. When developing and implementing a technology plan, thought must be given to the needs of special populations to insure they have an equal opportunity to learn and communicate.

Funding Equity

School districts differ in their ability to raise sufficient local tax funds to meet the needs of the students. They are responsible for supplying the hardware and software that will ensure that every student attains technological competence. When school districts do not have the capability to raise sufficient funds to purchase necessary hardware and software for a technology plan, the students are at a disadvantage. The situation should demand the attention of the government at a state/provincial level. Every state/province should provide the basic technological needs of every student regardless of where that student lives. Some states/provinces have approved programs of assistance for the purchase of hardware and software and this is an encouraging sign. Technology has become such an important part of the instructional program for students that it is necessary for every state/province to take responsibility for financial assistance.

Personnel and Staffing

Personnel Outsourcing

The field of technology is extremely fast-changing. It is necessary for school personnel to receive constant updates on developments in the field. This is a tremendous job that can be impossible for school personnel to adequately maintain. Some school districts outsource contractual employment of specialists and systems administrators rather than continually updating school personnel. This avenue for obtaining technology expertise may offer an attractive alternative to traditional staffing practices in certain situations.

Finding Competent Project Personnel

Finding competent, trustworthy consultants, engineers, and project personnel is key to the success of any project. The selection, training, and supervision of the personnel who will be responsible for the design, installation, and maintenance of the technology infrastructure requires thoughtful planning. Job descriptions must be written, qualifications determined, and an applicant pool should be identified for each position.

System Management–Daily Operations

Determining who will oversee the daily operations of the system, be responsible for upgrades, and provide leadership for future planning is crucial. Who will conduct the system maintenance, such as troubleshooting and school site visits? Personnel must be trained to operate and maintain the system, and apply the technology effectively for instructional and administrative purposes. School districts have widely varying resources regarding technology literate and competent staff. The school district may handle the entire project staffing requirements in-house, or may choose to outsource various aspects of the project.

Professional Development

The school district must provide sufficient support staff to maintain an ongoing technology plan. Support staff, faculty, and administrators need to receive constant updates on the latest developments in technology. A systematic and on-going professional development program should be created for all users of technology in the district. There are many sources of help to meet this demand. The appendix contains a listing of professional organizations that provide such training.

Infrastructure

New Construction vs. Renovation/Modernization

The technology infrastructure planned for new construction is generally different from the technology infrastructure planned for the renovation or modernization of an existing facility. Existing facilities place many constraints on the design of the technology infrastructure such as lack of or insufficiently sized conduits for cabling, insufficient electrical capacity and wiring, insufficient ventilation and cooling capacity, and lack of space for telecommunications closets, labs, technical service, and storage areas (Failla and Birk, 1999). These obstacles may add tremendous costs to the renovation/modernization project. Wireless solutions are becoming increasingly available, affordable, and reliable and should be investigated as an option, especially for enhancing the technology infrastructure in older buildings.

Cabling Standards

Cabling should be designed to ensure the success of the network it supports with the future technology requirements of the facility in mind. It is an expensive part of the facility infrastructure and it becomes integrated into the structure of the facility.

Cabling must be selected for its ability to enable the technology application and also must take into account local building codes and fire and safety standards. In case of a fire, cables that run through walls or between floors of a building may become a conduit to spread the fire. Noxious fumes emitted from burning cable coverings also are a hazard. Cables are designated for specific installation requirements such as vertical (between-floor) installation and plenum installation. A multitude of private companies, government bodies, and national and international organizations regulate and standardize cable specifications. In the United States, organizations such as Underwriters Laboratory (UL), Institute of Electrical and Electronic Engineers (IEEE), and the Electronic Industry Alliance and Telecommunications Industries Association (EIA/TIA) issue specifications for cable materials and installation. The standard most widely used by local licensing and building inspectors is the National Electrical Code (NEC). Canada and other countries have similar counterpart organizations and government agencies that provide the same kind of regulation and assistance. Planners should consult with state/provincial departments of education, building authorities, and trusted industry consultants when developing the cabling plan for the facility.

Cable Options

There are five cabling options for networking communications systems: Unshielded Twisted-Pair (UTP), Shielded Twisted-Pair (STP), Coaxial, Fiber-Optic, or Wireless (Dyson, 1999). The wireless LANs or LANs with wireless components can solve difficult infrastructure problems especially in renovation or facility modernization projects. There are wide performance and price differentials between the cabling options.

Cables are most widely rated by the EIA/TIA cabling standards: Category 1 is designated for UTP telephone cable, Category 2 is for UTP cable use at speeds up to 4 Mbps, Category 3 for UTP cable use up to 10 Mbps, Category 4 is the lowest acceptable grade of UTP cable for use with 16 Mbps token-ring applications, and Category 5 is used for 100-ohm, four wire twisted pair copper cable for speeds up to 100 Mbps and is acceptable for Ethernet or ATM applications. Category 5 cable is resistant to "cross-talk" (interference from a physically adjacent channel or cable) when installed properly (Desrosiers, 1999). Category 5e cable is used with 1,000 Mbps over short distances and Category 6 (awaiting ratification) can be used with 1,000 Mbps at longer distances.

Unshielded four-pair twisted cable is the least expensive wiring and the installation procedure is familiar to many technicians. UTP also can be used for the facility's phone system; however, because of cross-talk problems, do not run analog voice telephone and data signals on twisted pairs within the same outside sheathing. The UL and EIA/TIA standards have made UTP practical for all network installations. Many organizations find UTP to be the preferred cabling solution.

Shielded twisted-pair cable costs about three times UTP wiring, is difficult to work with, and cannot typically be installed by local technicians. STP is used for token-ring networks.

Coaxial cable is used for Ethernet installation. Thin Ethernet cable (RG-58) costs a little more than UTP per foot. Special attention such as using silver plated connectors and investing in a high-quality crimping tool is required on coaxial connections. Quality connectors may cost more, but will be worth the cost. The thick Ethernet cable used as the backbone in typical installations requires special handling and is hard to install but will last as long as the building if properly installed.

Fiber-optic cable is usually quite expensive, but is very secure and reliable. It has a very high bandwidth and is becoming more available on the market. Fiber is a good idea for linking buildings or connecting wiring closets. Fiber has the least attenuation (loss in signal power over distance) of the cabling options. There is no current need for fiber connections to desktops in school facilities, except in very specialized situations.

Moving Information on Coaxial or Telecom

Both the telecom and cable industry offer services on a broader bandwidth now to schools through their respective cables and wires. Digital Subscriber Line (DSL) and Cable

Modems are growing in use to expand information throughput from the web to the computer or TV. Consider the following when choosing a mode of transmission:

- possible vulnerability to signal interference with other devices
- possibility of loss of signal downtime due to weather, damage, or electrical surges
- type of information carried
- speed at which the service can be recovered should a problem occur (Coulter, 2001, personal communication)

In some areas, utilities are beginning to bundle services to the schools in collaboration with telecom companies to bring fiber to schools.

Wireless Communication

Wireless networks are extensions of cabled networks. Many school facilities are utilizing wireless solutions where cable is difficult to install or where mobility is desired. The adoption in 1999 of the IEEE 802.11HR standard specified signaling at 11 Mbps across the radio link used in wireless solutions. Adoption of this standard has removed many of the system incompatibility barriers that existed in the wireless domain. The most common current application is basically a LAN configuration utilizing a radio link (access point) to link the wired Ethernet access point to wireless desktops or laptops. Any classroom or office with an Ethernet drop can become an instant computing lab using a mobile hard-wired server with an access point to transmit the radio signal to wireless equipped laptops or desktops. Some wireless systems boast a connection radius of up to 2 miles. Within buildings, repeaters may be strategically spaced so that an entire building can be connected without cables. Distance and signaling speed have an inverse relationship. Trying to raise the parameter of either one without sacrificing the other always raises the cost. Currently, this relationship makes it difficult to install a wireless system that is cheaper or faster than a wired solution. The rapid advancement in wireless technology heralds new and exciting options for the technology planner for school facilities. At the same time, there is some concern regarding the extent of safe use of wireless communication within a confined area such as a classroom. Educators need to be aware of this concern when implementing a communication system that incorporates wireless communication in the classroom. Research will have to be done in this area to give educators direction on this means of communication.

Communications Equipment Room and Communications Closets

A Communications Equipment Room (CER) is the entry point for communications systems into the building. It houses the head-end equipment of the school's communications systems and as such also functions as the terminal point for external systems such as telephone company lines, cable television system connections, and fiber optic cables. The CER is connected, preferably by fiber optic cables, to communications closets for horizontal distribution to the end user. The CER also may house file servers or mini-computers for the data systems or be the point where servers are connected to facility cabling. The CER may be the source for delivery of communications to other buildings. The room must be secure, climate controlled, and not located in the vicinity of plumbing. The room may vary between 150–500 square feet. The room must be serviced by an uninterruptible power supply (UPS). EIA/TIA 569 provides good guidelines for CERs.

Design professionals must plan for the strategically located space needed to cluster wiring hubs, routers, and other devices. Communications Closets (CCs) are the distribution point for communications cable. In facilities with limited applications, the functions of the CER and a CC overlap. The CCs should be centrally located near user areas and connected to user areas. The number of CCs is a function of the number and distance of user areas. However, there should be a minimum of one CC per floor. Copper cable runs used for Ethernet traffic must not exceed 290 feet. These "closets" should be connected with fiber where practical. The space must be climate-controlled and backup power should be provided. The CC must not be located in the vicinity of plumbing. Security must be considered for the CC. System documentation and detailed cable drawings representing the CC must be provided to each school facility. The size of the CC may vary between 50-120 square feet. The closet must be serviced by an uninterruptible power supply (UPS). EIA/TIA 569 provides good guidelines for CCs.

Physical topology describes the route of networking cables linking various nodes. In older buildings, the planner may find a Thin Ethernet networking

plan that uses a station-to-station (series) wiring scheme which is termed a bus topology. This installation requires less wire, is cheaper to install, but is subject to total failure of the network if any connection is faulty. Modern Ethernet networks use a hub topology to overcome this problem. Hubs may be active or passive. Active hubs amplify transmission signals to extend cable lengths and ports, while passive hubs split the transmission signal to allow additional workspaces to be added, usually at a loss of distance. In a star network topology, the hub can be a controlling device. A bus topology allows all network nodes to receive the same message from the network cable at the same time. Ring networks can cover greater distances than star or bus networks. Token Ring uses token passing protocol to regulate network traffic. Older ring networks were susceptible to failure of the entire network due to the failure of just one node. New ring configurations have been designed to reduce the danger of network failure.

Portal devices (bridges, routers, and repeaters) allow access to the network's backbone cable so messages may be regulated, segmented, extended, and even protected depending on the device.

- Bridges can join two local area networks. Bridges use media-access control (MAC) protocols that enable them to link different cabling such as fiber and coaxial cable. The access points in wireless networks are bridges linking the Ethernet and radio wave adapters.
- Routers read the address of each message and determine whether the addressee lives over the bridge. If the mes-

sage does not need to cross the bridge, the router does not send it, thus reducing traffic on the network. Routers can differentiate and translate between the various cable and signaling schemes.
- Repeaters perform the simplest function of the portal devices. Repeaters enable the extension of a network cable by re-timing and regenerating the message packets or frames.

Servers perform a vide variety of tasks. Depending upon configuration, they may be dedicated to a single task, such as e-mail services, or serve two or more functions. Common server functions include: file and print sharing; database serving; CD-ROM sharing; application serving; mail serving; and Web services.

- The file server that makes hard disk storage space available, responds to requests for data actions routed from application programs, and handles simultaneous requests for identical data. File servers are typically robust, noisy machines.
- Print servers are computers that allow multiple workstations to share the same printer. Print servers and file servers can be combined if the facility generates less than 50 pages of plain text per hour, but the shared printer must be located close to the server because of the distance limitation of parallel-port functions. This limitation, the noise generated by a robust file server, and the required access to the shared printer may cause the facility planner difficulty in finding a suitable location for a combination file and print server.
- Communication servers in school facilities generally act as gateways to the Internet, but they also can be used to allow sharing of expensive, high-speed modems. A communication server requires a powerful CPU to perform the necessary real-time operations. It is recommended that this server be located on a computer dedicated to communication server function.

Horizontal Wiring

The horizontal cable system connects voice, video, and data from the communications closet to the end use application, typically an instructional area or classroom. The components of the system include coaxial cables, Category 5 copper data cables and Category 3 copper telephone cable. State or provincial departments of education have varying product performance standards that impact the choice of cabling either directly or indirectly. School business officials and planners should consult with state/provincial departments of education, local building authorities, and trusted industry consultants when developing the configuration of technology for the classroom. The appendix contains a listing of sources for help in developing facility specifications.

Internet Connectivity

The school facility may utilize the Internet in three ways: hosting a web site for public access, allowing home access to school resources, and allowing individual users to access the Web for research and Web communication (Derfler, 2000). To take full advantage of the rich resources on the Internet, a district needs to have a high-speed connection to the Internet. With a high-speed connection, all users on the network have simultaneous access to Internet resources. A district also could opt to provide dial-up to the school network, giving local call access to the Internet from home locations. The line is connected to the district's computer network. Facilities with a small number of users or utilizing limited Web-based applications may consider using multi-point protocol (MPP or MPPP) that allows a dial in connection to two or more parallel phone lines. Modern modems typically connect at approximately 40 kilobits per second (KBPS) so three parallel lines will allow 120 KBPS access. This compares to a typical ISDN connection of 128 Kilobyte (KB).

Broader applications for wireless connectivity via satellite are increasingly giving Internet access to remote locations. The technology planner should check with the technology division of the state/provincial department of education to determine the best connectivity options that are available and practical for the intended application.

Anticipated Traffic Patterns and Bandwidth Consumption

Bandwidth is a measurement of the quantity of data a network can support. The concept of bandwidth can describe the capabilities of a computer network or the capabilities of a phone system. Generally speaking, the greater the bandwidth of a system, the more information the system can handle and the faster and cheaper that information can travel through the system. Simply put, buy all the bandwidth that can be afforded, keeping in mind any future additional technology enhancements that may be incorporated in the facility.

There are five types of information that are transmitted over the communication system. Data (text) requires the smallest amount of bandwidth, about 1 Kilobyte (K), graphics (pictures) typically require 1-5 K, sound/voice (talking) may require 25-50K, animation (moving graphics) and video (moving pictures) may require 500K per transmission.

Video System Connectivity

Video systems in schools are more accurately described as integrated video/audio systems, except in the instance of closed circuit surveillance systems. These integrated systems include the one–way broadcast that is delivered via a roof top antenna, cable TV, satellite, or microwave link. Many school facilities, however, now house television production studios. Two-way, or interactive integrated systems, enable interactive distance learning, video conferencing, and other applications. These applications require combinations of the different types of information to be relayed in an asynchronous transmission mode (same speed upstream and down-stream) and require large bandwidths. Asynchronous Transfer Mode (ATM) is a connection-oriented protocol for transmitting voice, video, and data over high speed LANs and WANs. ATM is widely used for interactive distance learning.

Voice and Telephone System Connectivity

These systems traditionally consisted of telephone systems, public address systems, two-way radio, and voice messaging. The primary use of these systems has been administrative (Horack, 1999). Now, voice communication in the classroom is regarded as an enhanced learning (and security) tool. Traditional twisted pair wiring is now capable of carrying video, data transmission, and voice lines with full motion in real time. When planning or upgrading present facilities, consider the potential integration of voice and data over the same pair of wires.

Terminal Hardware

The selection of terminal (end-user) hardware is determined by the user applications (i.e. instructional, administrative, or communication). The goal is to procure hardware that is expandable, compatible, scalable, reliable, usable, and affordable. The Central Processing Unit (CPU) may be a desktop unit, laptop unit, or wireless hand held device. The computing power required also is relative to the application. Schools should purchase all the computing power that the budget will allow. The CPU should have the appropriate networking or internet connection. In some instances, removable storage may not be desirable on student user

terminals due to virus concerns. To reduce eye fatigue, VGA monitors should have 17-inch screens. Universal Serial Bus (USB) connections are recommended today for the networked peripherals connected to the terminal, but the next technology iteration might bring something different. The peripherals connected to the terminal are determined by the application of the user. Peripherals typically include printers, mice, keyboards, external modems, and external CD or DVD drivers. Instructional uses demand incorporation of a wide array of hardware components particular to the specific learning objectives. Hardware options include equipment used for audio-visual presentations and web production, wireless/wired touch panel control systems, integrated point-to-point and/or multi-point video conferencing, testing pads, electronic simulators, health equipment, physics modules, automotive trainers, virtual reality headsets, headphones, and wireless audio control/switching systems. It is impossible to list all of the possible hardware purchases that will accompany a technology upgrade or installation. Once the purpose and use of technology is determined, the users should have input into the technology design. The design should allow for sufficient capacity for expansion at a later date.

Security Issues

Technology security issues involve protecting the physical assets (hardware and software) from theft or damage, and protecting the data from accidental or intentional loss or corruption and unauthorized use. Much of the data handled in schools is considered confidential and requires the placement of security measures to maintain the integrity of the data. The managers of school-based technology systems must develop and implement a security policy and ensure that all users are aware of and comply with the policy. Security policy and procedures must be reviewed constantly to ensure that the system is effectively protecting the assets and the data.

Physical Security

There is no substitute for controlled access and vigilance to prevent theft and vandalism of the physical assets. All equipment rooms, wiring closets, and offices must be secure. There must be procedures in place to assure that only authorized staff can enter these areas. School personnel must closely monitor the instructional areas to prevent unwarranted student access. Doors to all premises must always be locked when unattended by responsible school personnel.

Care must be taken to reduce other risks to the physical assets, such as:

- Premises must be free from unacceptable risk from flooding, vibration, or dust
- There must not be an inordinate amount of combustible material stored in the same room as the computer system
- Air temperature and humidity must be controlled to within acceptable limits
- Computing equipment should be electrically powered via an uninterruptible power supply (UPS) to provide a minimum of 15 minutes of operation in the event of a power blackout, adequate protection from surges and sags, and trigger an orderly system shutdown when necessary
- There should be smoke and thermal detectors in all areas
- Areas under floors should have smoke and water detectors

User Access

Policy and procedure must be in place that allows control of system access. Proper authorization and identification should be required of any unknown person entering the area. Someone in authority must issue user-id and passwords before users can logon to the system. Ideally, the Operating System will support a password aging facility that forces a password change on the first login. The life of a password should be between 3 and 6 months. Software exists that allow for users to be given varying levels of access to the system.

Data Security

Data should be backed up at least once per working day. The back up procedure should facilitate recovery to at least the start of business on any weekday of a failure, and provide at least one more level of backup to a previous time, to cover the case of the failure of the primary backup media. Back up data should be stored off-site, preferably in a neutral site such as a local government building or a bank. Physical removal of tapes by an administrator should be discouraged as a solution. There should be an audit of backup data at least once every six months.

Firewalls

A firewall is a barrier established in the system's hardware or software, or in combination, that allows the information systems manager to monitor and control the flow of traffic between the school's LAN and the Internet. The firewall checks each incoming message to insure that there is a valid reason to enter the school LAN from the Internet and prevents outsiders from accessing the school's information technology system and school data. Firewall software is available for a variety of operating systems. The network managers sometimes find it expedient to put "holes" in the firewall to enable streaming audio, web meetings, and web broadcasting. Unfortunately, this process allows exploitation of the system. Some schools may wish to consider developing a collateral public access Web site that is hosted externally by a Web hosting service.

URL filtering may be considered as a type of reverse firewall. This prevents users from accessing undesirable or objectionable Web sites. An Internet Service Provider (ISP) can implement a customized URL filter or the filter can be installed on a server in the system. The growing public concern regarding student access to objectionable materials available on the Web make URL filtering a very desirable feature for the information system.

Environmental Issues

As important as security is in a technology program, there are several other issues dealing with the quality of the physical environment that need to be considered. These issues concern potential conditions that might negatively impact the efficient use of hardware.

Asbestos Removal

This material is usually found in older buildings as a means of insulation for piping or walls. Buildings that are over thirty years old may be suspect of having asbestos somewhere in the building. The presence or absence of asbestos can be determined only through a physical inspection by a licensed asbestos abatement contractor. Although commercial buildings do not have to be inspected for the presence of asbestos, public and private schools are required by AHERA (Asbestos Hazard Emergency Response Act), to be inspected for the presence of asbestos (Earthman, 2000).

Asbestos is not necessarily a hazard so long as it is not disturbed. In most renovation projects, however, the removal of asbestos is considered part of the overall work plan regardless of the condition of the material. School district authorities must make certain that such a plan is in place before any renovations begin.

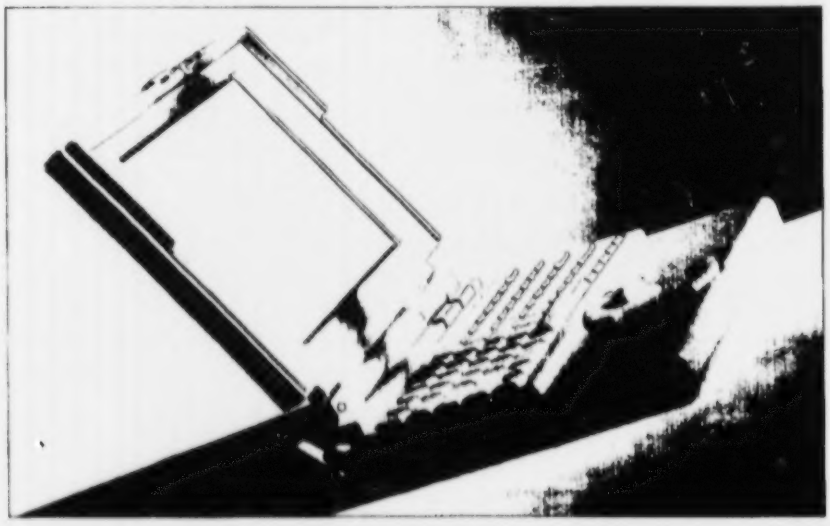
Commercial firms that are licensed by the state or province to remove asbestos must be employed to successfully complete the removal. School district authorities can easily find contractors who are licensed by the state or province to perform such work simply by contacting the appropriate state educational agency.

Carpeting and Static Electricity

The installation of carpeting throughout schools can cause problems of static electricity, which may lead to damage to computers and software being erased. When carpeting is installed, the school district must develop appropriate specifications. Most schools have found commercial carpeting with less than 3.O KV at 70 degrees and 20% humidity (AATCC 134) provide floor covering that will not generate static electricity (Eckhoff, 2001).

Increased Air-Conditioning/ Ventilation Requirements

The heat gain in a typical classroom is generated by the exterior envelope, students, lighting, and a small amount by equip-



ment. When computers are placed in classrooms, there is a need for additional air conditioning. If 4-5 computers are in a classroom, the amount of air conditioning needed is increased by as much as 15% from what would ordinarily be needed (Lesley, 2001). This percentage is multiplied by the number of instructional spaces in the building to account for the total building air conditioning needs. In a computer lab with 25-30 computers, the increase can be as much as two and one-half times the amount for ordinary classrooms. In new construction or renovations, design professionals will properly size the air conditioning needs for the school building taking into account the increased demands of computers (Tiernan, 2001).

Grounding and Sources of Electrical Interference

Installation of appropriate surge protection at all branch panels feeding computers is needed to eliminate electrical interference. Most school districts require the neutral wire one size larger than the circuit feed to minimize circuit interference from the computer equipment. No special grounding is needed if the installation meets the requirements of the local electrical code (Schoff, 2001).

Working With Vendors

School business officials often use vendors as they design, equip, install, implement, and maintain the technology infrastructure of the facility. Hiring the wrong vendor will be a frustrating and costly endeavor. Make sure that vendors understand the interaction between teachers, students, and technology. If you have a specific need, provide the details in the selection process so the requirements are addressed specifically. Ask for at least three references. Vendors should exhibit expertise in the desired area. Wherever possible, get school personnel involved. Assign staff members to participate in projects with contractors; similar projects may be handled with school personnel in the future.

Vendor Expertise

Technology vendors may fall into the following categories:

- *Independent Designer*-this consultant is generally the first person or firm contacted in a facility design or retrofit. The consultant may provide a needs analysis, a strategic plan, or a design. The consultant should have specialized experience in K-12 education and be able to provide multiple options for particular design issues. Typically, they provide expertise but not a product.
- *Outsourcer*-an external entity that actually takes ownership or control of the computer system or network.
- *System Integrator*-a firm that designs or enhances the system or network while allowing the school to retain control of the system and responsibility for day-to-day maintenance.
- *Vendor/Supplier*-many vendors will offer to design the system, write specifications, and assist with the bidding process. If a school district hires a vendor/dealer to serve as its technology consultant, they should not allow the vendor or dealer to bid, sell, or install any portion of the work required on the project.
- *Installation Contractor*-an individual or firm performing the physical installation of infrastructure components.

Developing the RFP

Requests for proposals should include: (1) project description, including the scope, boundaries, objectives, tasks, and skills required; (2) outline of the institution's contribution to the project, this may be personnel or other resources; (3) statement of which services will be provided by the contractor and the process to be followed; (4) directions for the consultant's fee proposal; (5) deadline for receiving proposals and the number of copies required; (6) evaluation criteria for the contract; and (7) school point of contact information.

Selecting the Vendor

Proposals should be reviewed with attention given to the specificity of the proposal's timeline and task line. Specify chain of command and decision-making authorities for different functions within the school district before beginning to interview contractors.

Determine the final product desired and ask direct questions to evaluate the bidders understanding of the scope and requirements of the contract and the corporate capacity, technical knowledge, and skill levels. References must be checked. Is the vendor bonded? Does the contractor carry sufficient liability insurance? Does the personnel of the bidding firm appear to be compatible with school personnel?

Negotiating With the Vendor
Strive for flexibility in the timeline but be rigid in the budget. Negotiate costs because contractors usually expect budget negotiations. Establish performance incentives and penalties to ensure critical tasks are accomplished to specification and according to the timeline. Put all aspects of the contract in writing, using unambiguous language and specifying the satisfactory performance criteria. Include an escape clause in the contract if possible, allowing the school to void the contract with due cause.

Getting Help

Making decisions regarding technology needs and implementation is indeed a daunting task for any public school official. Considerable time and information are needed by all involved to make rational decisions. The need for information is critical to good decisions. One great pitfall is not seeking expertise assistance when trying to plan and implement a technology installation. Assistance and advice is always available to help with problems. A good source of information is learning from the experiences of other school district personnel. The lessons they have learned can be applied to other situations. Professional journals often feature such experiences. In addition, professional organizations conduct workshops and conferences devoted to the subject of technology in schools.

The question regarding technology needs and purposes in the school is something that cannot be answered by one person. For that reason, decisions regarding technology needs are usually made through the cooperative effort of instructional and administrative personnel. Having multiple sources of information will lead to a working knowledge of what technology is needed.

Many times, the administrator may need or want some information regarding certain aspects of technology that are not available within the local school district. There are several sources of good impartial information on all technology problems. Outside of the local school district, a source of information is the National Clearinghouse for Educational Facilities. The U.S. Department of Education sponsors this organization for the purpose of providing free information to all school districts. NCEF can be reached by telephone at the toll free number: 888-552-0624 or through e-mail at ncefinfo@edfacilities.org.

The National Forum for Educational Statistics (NFES), which is listed under the National Center for Educational Statistics, has two very good publications available that deal with implementing and safeguarding technology systems. These sources are listed in the reference section and are obtainable through http://nces.ed.gov/pubsearch/search.asp.

Journals of all major professional organizations contain references to technology application. Some examples are listed in the appendix. In addition, there are several electronic Web sites listed in the appendix that can be accessed for appropriate information.

Information on the planning process can be obtained through many sources such as professional books, texts, and pamphlets issued by various organizations. A section listing a sampling of such resources is also contained in the appendix.■

Appendix A

Sources of Help On-line

Electronic Journals

The Technology Source - http://horizon.unc.edu/TS

K-12 Tech Watch - k12techwatch@lists.eschoolnews.com

Web Sites

Educators Guide to School Networks - http://fcit.coedu.usf.edu/network - an excellent tutorial on computer networks. Protocol, hardware, cabling, topology, and software issues are considered. A glossary and a list of references also are provided.

eSchool News online - http://www.eschoolnews.org - subscription news service on technology

Electronic School - www.electronic-school.com - an award-winning quarterly technology magazine for K-12 school leaders

LAB Resources - http://www.elabresources.com - assistive technology and special education products available for education discount

North Central Regional Technology in Education Consortium - http://www.ncrtec.org/

Several states have developed facility specifications for a broad array of applications in the K-12 environment. Two examples, Florida and New Jersey, are available at: http://www.state.nj.us/njded/techno/facstan/facstan2.htm#3II

Price Watch - http://www.pricewatch.com - resource for comparing hardware and software pricing

Information on grants and funding opportunities:

American Association of School Administrators
http://www.aasa.org

Computers for Learning
http://www.computers.fed.gov

Council of Foundations
http://www.cof.org

Distance Learning Funding Sourcebook
http://www.technogrants.com

Federal Register
http://www.ed.gov/legislation/FedRegister/announcements/index.html

Foundation Center
http://fdncenter.org

Foundations Online
http://www.foundations.org

George Lucas Foundation
http://www.glef.org/grants/grant.html

Grants and Other (People's) Money
http://learn.arc.nasa.gov/grants/grants.html

Grants Web
http://web.fie.com/cws/sra/resource.htm

Science and Math Initiatives
http://sami.lanl.gov

Milken Family Foundation
http://www.mff.org

MSDN Academic Alliance Community
http://www.msdnaa.net

National Science Foundation
http://www.nsf.gov

Grants and Contract Information
http://www.tea.state.tx.us/grant

Telecommunications Infrastructure Fund
http://www.tifb.state.tx.us

Planning Resources

Books

Earthman, G. I. (2000). *Planning Educational Facilities For The Next Century*. Reston, VA: Association of School Business Officials International.®

National School Boards Association. (1998). *Technology & School Design: Creating Spaces for Learning*. Alexandria, VA: Author.

Picciano, A. G. (1998). *Educational Leadership and Planning for Technology*. Upper Saddle River, NJ: Prentice-Hall, Inc.

Two excellent publications dealing with the implementation of a sound technology program and with safeguarding sensitive material are:

Technology @ Your Finger Tips: A Guide to Implementing Technology Solutions for Educational Agencies and Institutions – NCES No. 98293, January, 2001.

Safeguarding Your Technology – NCES No. 98297, September 22, 1998.

Professional Organizations

The following organizations publish journals that sometimes contain articles that provide information about technology in public schools.

Association of School Business Officials International®
11401 North Shore Drive, Reston, VA 20190
(703) 478-0405
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Appendix B

BASIC TECHNOLOGY CHECKLIST

This 20-item checklist can be used by a school district in several ways. It could be used to help a school district develop a comprehensive technology plan. The checklist also could be used to determine if an existing technology program is complete.

1. ❑ Does your school district or school organization have an approved technology plan that addresses all necessary components?
2. ❑ Does the school district plan state expressly the kinds and types of technology support that the educational program requires?
3. ❑ Does every school building have a comparable technology plan that was cooperatively developed?
4. ❑ Are there safeguards to insure that all students have equal access to technology hardware and software?
5. ❑ Does the school district fully employ available technology in a systematic public relations program?
6. ❑ On specifications for either new buildings or renovations, do they account for extra space for computers in the classroom?
7. ❑ Do the building specifications state that all instructional and administrative areas in the school building are to have capability of voice, video, and data reception and transmission?
8. ❑ Does the school district have an on-going professional development program for all members of the staff?
9. ❑ Does the school district allocate and spend an amount of funds to fully implement the technology plan?
10. ❑ Has the school district explored the possibilities of leasing hardware?
11. ❑ Does the school district have uniform technical specifications for the purchase of all hardware?
12. ❑ Does the school district have responsible policies and procedures for the safeguarding of physical equipment and software?
13. ❑ Does the school district have sufficient policies regarding the legal use of personal data?
14. ❑ Does the school district have a sound procurement policy for the purchase of hardware, software, and services for all locations?
15. ❑ Does the school district have a systematic plan for networking a minimal number of computers in every building on both local and wide area networks?
16. ❑ Does the school district have an adequate support staff for technology applications so there is little "down" time in the school buildings?
17. ❑ Is there an un-intrerruptive power supply line into each building to service computers?
18. ❑ Does each building have a secured Communications Equipment room and appropriate Communications Closets?
19. ❑ Does the school district have a leased line high-speed connection to the Internet that in turn is available to each building?
20. ❑ Does the school district have the capability of providing distance learning opportunities to students and community members?

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Facilities Project Team

ASBO International® and Johnson Controls, Inc., joined forces to examine crucial issues that impact school facility infrastructure. *Technology Solutions for Schools* is the third of three publications to assist school business officials with the challenges of improving school facilities. The first publication, *Financing School Facilities*, and the second, *Maintenance & Operation Solutions: Meeting the Challenge of Improving School Facilities*, may be purchased on ASBO's® Web site at www.asbointl.org. To research and gather this type of information, a project team was assembled from a cross-section of ASBO International's® volunteer committees. Members of this project team include the following:

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